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Claims

We claim:

- 5 1. A method of reducing, preventing, ameliorating, or reversing oxidative DNA damage in a subject, comprising orally administering a therapeutically effective dose of a natural astaxanthin extract to the subject, whereby the natural astaxanthin extract reduces, prevents, ameliorates, or reverses the oxidative DNA damage.
- 10 2. The method of claim 1, wherein the natural astaxanthin extract comprises predominantly mono- and di-ester forms of astaxanthin.
3. The method of claim 2, wherein the natural astaxanthin extract comprises no more than about 5% free astaxanthin, about 45-50% astaxanthin monoesters, about 10-40% astaxanthin
15 diesters, and other carotenoids in the remaining percentage.
4. The method of claim 3, wherein the other carotenoids comprise β -carotene, lutein, canthaxanthin, or a mixture of two or more thereof.
- 20 5. The method of any one of claims 1-4, wherein the natural astaxanthin extract is derived from yeast or microalgae.
6. The method of claim 5, wherein the natural astaxanthin extract is derived from
 Haematococcus pluvialis.
- 25 7. The method of any one of claims 1-6, wherein the astaxanthin in the extract is greater than 95% (3S,3'S) astaxanthin.
8. The method of claim 7, wherein the astaxanthin in the extract is about 100%
30 (3S,3'S) astaxanthin.
9. The method of any one of claims 1-7, wherein the astaxanthin in the extract comprises about 55-62% E-astaxanthin, about 13-18% 9Z- astaxanthin, and about 23-29% 13Z-
 astaxanthin.
- 35 10. The method of any one of claims 1-9, wherein the natural astaxanthin extract further comprises fatty acids, and the fatty acids are one or more of Lauric, Tridecanoic, Myristic, Pentadecanoic, Palmitic, *cis*-9-Palmitoleic, Heptadecanoic, *cis*-10-Heptadecenoic, Stearic, *cis*-9-Oleic

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and/or *trans*-9-Elaidic, *cis*-9,12-Linoleic and/or *trans*-9,12-Linoleidic, Arachidic, alpha -Linolenic, *cis*-11-Eicosenoic, Linolenic, Heneicosanoic, *cis*-11,14-Eicosadienoic, Behenic, *cis*-8,11,14-Eicosatrienoic, *cis*-13-Erucic, *cis*-11,14,17-Eicosatrienoic, *cis*-5,8,11,14-Arachidonic, and *cis*-5,8,11,14,17-Eicosapentaenoic acids.

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11. The method of claim 5, wherein the natural astaxanthin extract is derived from a *Phaffia* species.

12. The method of any one of claims 1-11, wherein the natural astaxanthin extract is
10 produced by a process comprising supercritical carbon dioxide extraction.

13. The method of any one of claims 1-12, wherein the natural astaxanthin extract is administered to the subject in combination with at least one additional biologically active compound.

14. The method of claim 13, wherein the biologically active compound is a carotenoid,
15 an antioxidant, a vitamin, or a second natural extract.

15. The method of any one of claims 1-14, wherein the natural astaxanthin extract is:
dissolved in oil;
20 dispersed in oil;
dispersed in an aqueous medium;
homogenized in an aqueous medium;
encapsulated;
processed into dry material; or
25 a combination of two or more thereof.

16. The method of claim 15, wherein the natural extract is processed into dry material, and the form of the dry material is stabilized beadlets, a powder, a granule, or a combination of two or more thereof.

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17. The method of any one of claims 1-14, wherein the natural astaxanthin extract is formulated as a liquid, a liquid capsule, a solid capsule or a tablet.

18. The method of any one of claims 1-17, wherein the natural antioxidant extract is
35 administered to the subject in a food or beverage product.

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19. The method of claim 1, wherein the therapeutically effective dose of astaxanthin reduces the oxidative DNA damage by at least 30% compared to a subject not administered the therapeutically effective dose of astaxanthin.

5 20. The method of claim 1, wherein the subject is human.

21. The method of claim 1, wherein the oxidative DNA damage comprises oxidative DNA damage in immune cells.

10 22. The method of claim 21, wherein the immune cells are cells, B-cells, monocytes, neutrophils, natural killer cells, splenocytes, or a mixture of two or more thereof.

23. The method of any one of claims 1-22, wherein the therapeutically effective dose is about 0.5-1000 mg astaxanthin per day.

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24. The method of claim 23, wherein the therapeutically effective dose is about 1-10 mg per day.

25 25. The method of any one of claims 1-22, wherein the therapeutically effective dose is about 2 mg per day.

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26. The method of any one of claims 1-22, wherein the therapeutically effective dose is about 4 mg per day.

25 27. The method of any one of claims 1-22, wherein the therapeutically effective dose is about 8 mg per day.